

AD 600759

Shelter Research 1200 - Shelter  
Environmental Studies, Subtask  
1232B - Environmental  
Instrument Package

6-P-10.50

SUMMARY  
OF  
RESEARCH REPORT

ENVIRONMENTAL INSTRUMENT PACKAGE

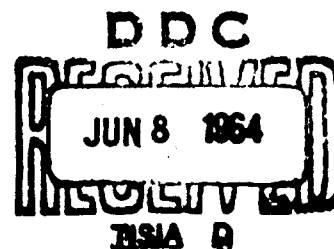
FOR A  
CIVIL DEFENSE SHELTER

MAY 1964

This is a summary of a report which has been reviewed in the  
Office of Civil Defense and approved for publication.  
Approval does not signify that the contents necessarily  
reflect the views and policies of the Office of Civil Defense.

Contract No. OJD-OS-62-216  
Subtask 1232 B

Thomas A. Edison Research Laboratory  
Division of McGraw-Edison Company  
West Orange, New Jersey



Summary Prepared in  
Thomas A. Edison Research Laboratory  
May 1964

## SCOPE OF WORK OF CONTRACT

"The Contractor in consultation and cooperation with the Government, shall furnish the facilities, personnel and other services as may be required to conduct and administer research on an environmental instrument package for Civil Defense shelters.

"The Contractor shall study and explore the requirements for environmental measurements, evaluate methods of measurement and available instruments with respect to complexity, reliability, cost and desirable modifications, and prepare specifications for an instrument package that is reliable, economical and suitable for use with little training. The environmental instrument package shall be used for the detection of the existence of unsatisfactory environmental conditions in shelters as may be required by measuring temperature, humidity, illuminations, noise, oxygen concentration and the presence of noxious gases such as carbon dioxide, carbon monoxide, hydrogen and hydrocarbon vapors.

"The Contractor shall determine the adequacy of instructions for use and information for interpreting instrument readings, and shall determine the requirements for packing and storing the instrument".

Within the above quoted "Scope of Work of Contract" it was determined that recommendations were to be developed covering the following areas:

1. environmental conditions that constitute potential hazards and those that do not.
2. the allowable tolerance limits of the hazardous conditions
3. hazards which are or are not, self-evident before their lethal limits are reached
4. suitable techniques and instruments to monitor the hazards
5. specifications for procurement of instrument packages for three sizes of shelter
6. adequacy of instruction material for use by inexperienced personnel
7. modifications and improvements to existing instrumentation.

## APPROACH

The research under this contract was divided into the following tasks:

1. Consult with authorities and review the literature on the selection of hazardous conditions.
2. Review and evaluate the literature with reference to the physiological aspects of hazard exposure.
3. Review and evaluate the literature with reference to detection techniques for the hazards.
4. Solicit manufacturers information and evaluate same for suitable instrumentation.
5. Purchase, test, and evaluate sample instruments.
6. Recommend and write specifications for three sizes of instrument packages.

It was assumed, in this study, that three sizes of instrument packages would be required: Type I for more than 1000 occupants, Type II for 10-1000 occupants, and Type III for less than 10 occupants. The cost and complexity of each would be in relation to the number of people within the shelter. Further, it was assumed that the time-in-shelter would be two weeks with effective sealing of the shelter during the first twenty four hours.

## FINDINGS

A review of research and tests dealing with this area of interest shows:

1. The components of an environment that may become dangerous and that will require monitoring devices are temperature, relative humidity, differential pressure; the concentrations of oxygen, carbon dioxide, carbon monoxide, nitrogen dioxide, hydrogen, and hydrocarbon vapors in toxic and explosive concentrations.
2. The tolerance levels of these components are time-dependent. They are, for a fourteen day exposure:
  - a. temperature and relative humidity (interrelated) - from 77°F and 100% relative humidity to 112°F and 10% relative humidity upper limit, to 52°F and 10% - 100% relative humidity lower limit.

- b. differential pressure (for shelter pressurizing only) - 0.2" W.G.
- c. oxygen concentration 13% to 66% by volume
- d. carbon dioxide concentration 5,000 ppm
- e. carbon monoxide concentration 20 ppm
- f. nitrogen dioxide concentration 5 ppm
- g. hydrocarbon vapor concentration, toxic - 100 ppm
- h. hydrocarbon vapor concentration, explosive - 30,000 ppm

3. Design ranges for monitoring instruments are:

- a. temperature - 25<sup>o</sup>F to 125<sup>o</sup>F
- b. relative humidity - 0 to 100% relative humidity
- c. differential pressure - 0 to 2.0" W.G.
- d. oxygen - 0 to 25% by volume
- e. carbon dioxide - 0.5% to 5.0% by volume
- f. carbon monoxide - 5 to 100 ppm
- g. nitrogen dioxide - 2 to 10 ppm
- h. hydrocarbon vapor, toxic - 25 to 100 ppm
- i. hydrocarbon vapor, explosive - 0 to 100% concentration.

4. Detection techniques suited to shelter requirements and personnel are for -

- a. temperature measurement, a liquid in glass or differential expansion thermometer
- b. relative humidity measurement, a sling psychrometer or animal membrane hygrometer
- c. differential pressure measurement, a liquid filled manometer or slack diaphragm gauge
- d. oxygen concentration, a torsional magnetic susceptibility type or depolarization cell type indicator
- e. toxic gas concentrations, glass tube indicators
- f. explosive vapor concentrations, a thermal combustion indicator.

5. Instrument packages for the three sizes of shelter have been evaluated. A procurement specification for each will include -

- a. Type I Shelter - a bimetal thermometer, an animal membrane hygrometer, a U-tube manometer, a susceptibility type oxygen detector, a thermal combustion type explosive vapor detector, and separate glass tube indicators for carbon monoxide, carbon dioxide, nitrogen dioxide, and toxic hydrocarbon vapors.
- b. Type II Shelter - a bimetal thermometer, a sling psychrometer, a U-tube manometer, an Orsat Type oxygen detector, a thermal combustion type explosive vapor detector, and separate glass tube indicators for carbon monoxide, carbon dioxide, nitrogen dioxide, and toxic hydrocarbon vapors.
- c. Type III Shelter - a sling psychrometer and glass tube detectors for carbon monoxide and carbon dioxide.

#### RECOMMENDATIONS

*an*  
The instrument evaluation phase revealed deficiencies in every device *existing equipment* that stimulated interest in innovative materials and new techniques. Recommended revisions to existing equipment relate to:

##### (1) Instruction Material,

- a. Attach brief operating instructions to the body of the device
- b. Calibrated scales with maximum allowable concentrations marked, should be an integral part of each device
- c. Give anticipated accuracy of readings with correction factors for temperature and altitude

##### (2) Shelf Life,

Extend shelf life of glass tube indicators to five years if possible. Package elastomeric materials and even the entire device, in an airtight plastic bag to protect components from deteriorating vapors.

##### (3) Air Sampling,

Standardize glass tube size, gas flow rate and gas flow volume for tubes of similar nature. If this is done, then a single air mover of universal design can be used with an overall saving in cost.

## New Instruments

a. Effective Temperature Indicator. A device can be made that will incorporate the effects of temperature and humidity in a single indication of Effective Temperature. It is self contained, requires no power and continuously in operation. The device could replace both the thermometer and hygrometer in Shelter Packages at a saving in cost.

b. Filament Type Hygrometer. The filament or hair hygrometer is limited in use by the fragile nature of the sensing element. It is recommended that the hair element be replaced by a plastic strip similar to those used in present day commercial humidistats.

c. Glass Tube For Oxygen. Glass tube detectors are available for all other gases of interest in shelter work except oxygen. It is recommended that development of such a tube be carried out for a detection range of 5% to 25% concentration.

d. Carbon Dioxide Detector. A unique method is under investigation for measuring carbon dioxide in air on a continuous basis. It uses the water ionization principle and has potential as a small, inexpensive device. Development of such a device for shelter use should be encouraged.

e. Exposure Detectors. A very interesting detector for carbon monoxide is presently made that has all the features of an excellent shelter instrument. It is very small (a dozen fit in the pocket) and requires only a sealed envelope to be opened. Exposure of a chemical to the gas changes the chemical's color. Unfortunately, the device is qualitative, not quantitative, so that a true hazard evaluation is difficult. It is recommended that development of a device of this character be carried out, one that might have several chemical sections, each sensitive to a different concentration of gas. Whatever direction is taken, the present device illustrates that the problem can be solved.